METHOD AND APPARATUS FOR DETERMINING THE PRESENCE OF THE USER BY A TELECOMMUNICATION TERMINAL

Technical Field

The present invention relates to communication systems and, in particular, to the routing of telephone calls and other telecommunication media.

Background of the Invention

Within the prior art, a well recognized problem in the routing of incoming telecommunication calls is determining if the user of the called telecommunication terminal is present at the telecommunication terminal. Within the prior art, it is known to utilize different mechanisms by which the user of the telecommunication terminal manually indicates that they will be absent from the telecommunication terminal. One well known telecommunication feature to do this is the "send all calls" feature which allows the user by actuation of a single or multiple keys on the telecommunication terminal to indicate that they will be absent. The problem with the first method of detecting the presence of a user is that it requires the user to perform a manual act.

Another method that has been utilized within the prior art to determine the presence of a user is to have the user carry on their person either an active or passive device that can be detected by the telecommunication terminal or by transducers interconnected to the telecommunication terminal. Such passive or active devices can operate at

radio, sonic, infrared or other frequencies. The problem with the second technique of detecting the presence of the user is that it requires the user to carry a special device that can be detected by the telecommunication terminal or another transducer.

Another method utilized in the prior art is to utilize the key strokes on a computer normally used by the user to determine if the user is in the presence of the telecommunication terminal which is assumed to be physically located with the computer. The problem with this third technique is that the user simply may not be utilizing the computer for long periods of time or the user may not even use a computer at all.

Summary of the Invention

The foregoing problems are solved by a method and apparatus for detecting a presence of a user at a telecommunication terminal by at least one of a change in the acoustical path around the telecommunication terminal and the body heat of the user.

Brief Description of the Drawing

FIG. 1 illustrates, in block diagram form, an embodiment for implementing the invention;

FIG. 2 illustrates, in block diagram form, an embodiment of a telecommunication terminal for implementing the invention;

FIG. 3 illustrates, in block diagram form, another embodiment of a telecommunication terminal for implementing the invention;

FIGS. 4-6 illustrate, in flowchart form, operations performed by embodiments of the invention; and

FIG. 7 illustrates, in block diagram form, another embodiment for implementing the invention.

Detailed Description

In one embodiment of the invention, the telecommunication terminal is equipped with speaker phone capability, a separate microphone, or other audio transducers. The ringing of the telecommunication terminal is utilized to determine the echoes that are being returned to the telecommunication terminal via the microphone of the telecommunication terminal that is normally utilized for the speaker phone functions. The telecommunication terminal utilizes the fact that the telephone is not being answered to determine what the probability is that the user is not present. Over a period of time, the telecommunication terminal determines the echoes that indicate presence or non-presence of the user based on whether incoming calls are answered by the user. A sufficient period of time is required to allow for the user simply not answering some calls.

In another embodiment, the user trains the telecommunication terminal to detect and to know the difference between echoes when the user is present to the telecommunication terminal and when the user is not in the presence of the telecommunication terminal. The user would

conduct a fixed training session during which the telecommunication terminal would ring both when the user is present and when the user is not present. Since during this training session, the telecommunication terminal knows when the user is present or not, it catalogs the echoes based on this knowledge.

As is well known to those skilled in the art, the presence of a human body within the speaker phone range is detected in the analysis of the echoes for some speaker phone operation. In addition, once the non-presence has been determined by the telecommunication terminal and relayed to the telecommunication switching system controlling the telecommunication terminal, the ringer will be rung once or not at all for subsequent calls. If the ringer is given one ring for subsequent calls, the telecommunication terminal can use the return echoes to determine if the user has returned. Note, in another embodiment the telecommunication terminal itself senses the presence of the user and will automatically route incoming calls to a call coverage path if the telecommunication terminal has determined that the user is not present. In yet another embodiment, the telecommunication terminal will cause ringing during periods of time during which there is some high probability that the user is not present, or at least will not be annoyed, to determine the echo characteristics of the environment in which the telecommunication terminal is present. For example, the telecommunication terminal could do this testing during normal non-working time.

The echo characteristics are determined by the acoustical path between the speaker (device producing the audio signal) and the microphone (device receiving the audio signal). The acoustical path is normally rather complex for an enclosed room or cubicle with different acoustical paths having more or greater delay in the return signal. In addition, the individual acoustical paths with attenuate the original signal in varying amounts. It is the determination of the difference in the acoustical path between when the user of the telecommunication terminal is present and when the user is not present. Furthermore, additional people in the room will also modify the acoustical paths. Indeed this is information that can be utilized to further determine whether a call should be rung at the telecommunication terminal.

In another embodiment, the telecommunication terminal includes an ultrasonic or subsonic transducer that transmits either continuously or in short intervals or transmits just prior to ringing the telecommunication terminal for an incoming call. The return echo from the ultrasonic or subsonic transducer is utilized to detect the presence of the user. The sonic transducer broadcasts pulses in a broad area, and it is the echo or lack of echoing of the sonic pulses that is utilized to detect the presence of the user. Again, the telecommunication terminal utilizing the sonic transducer may be trained by the user or utilized self-training on the basis of whether the user has answered a telephone call or not to perform the echo analysis. The advantage of embodiments utilizing a sub or ultrasonic transducer is that

the testing to determine if the user is present can be done on a relatively continuous basis without annoying the user.

In another embodiment, the telecommunication terminal is equipped with an infrared sensor that detects the heat from the user's body to determine the presence of the user. The infrared transducer would be tuned for the emissions that arrive from the spectrum normally given off by a human body. This would assist in masking other heat sources. Note, that the infrared sensor is simply determining a difference in the amount of infrared emissions being received to determine the presence of the user and not trying to fix the exact position in the location of the telecommunication terminal.

In another embodiment, short range high frequency radio signals are utilized to detect the presence of the user. The detection is done by the reflection or absorption of the high frequency radio signals by the user. Again, it is not necessary to determine the exact position of the user within the location of the telecommunication terminal but only to determine that the user is within this location.

FIG. 1 illustrates a system for utilizing and implementing embodiments of the invention. The detection of whether a user is close to their telecommunication terminal can be implemented on a digital telephone such as digital telephone 108 that is implementing either a proprietary digital protocol or an ISDN protocol. In addition, the invention can be implemented by an IP telephone such as IP telephone 112. IP telephone 112 can be a conventional IP telephone set or can be IP telephone functions being

implemented by a computer such as a personal computer. The IP telephones are interconnected to the telecommunication switching system 100 via wide area network (WAN) 111 which is connected to network trunk 106. Within telecommunication system 100, the switching functions are performed by switching network 105. CO trunks 109 interconnects telecommunication switching system 100 to public switching telephone network 116.

Control computer 101 controls the operations of telecommunication switching system 100. This control is performed by processor 121 executing programs and data out of memory 122. Overall control is performed by operating system 123 with the telecommunication functions being controlled by control 124. Processor 121 stores a variety of data in memory 122; however, only the telecommunication terminal status table 126 is illustrated. In one embodiment of the invention, it is telecommunication terminal status table 126 that is updated by processor 121 by execution of control 124 when a message is received from a telecommunication terminal indicating that a user is now present or absent from the vicinity of the telecommunication terminal. In response to another stimulus, e.g. incoming call, control 124 will utilize the information stored in telecommunication terminal status table 126 to perform specified operations, such as send-all-calls, based on the presence or absence of the user of the telecommunication terminal to which the incoming call is directed. Other operations performed by control 124 can also be influenced by the presence or absence of the user of a

telecommunication terminal as is well known to those skilled in the art. One skilled in the art would immediately realize that other types of telecommunication switching systems could be used.

FIG. 2 illustrates, in block diagram form, a telecommunication terminal such as telecommunication terminal 108 or IP telephone 112 of FIG. 1. Controller 201 performs overall control of the telecommunication terminal. User interface 231 consists of a handset, buttons, indicators, displays, etc. that are normally found on a telecommunication terminal. Controller 201 receives and transmits telecommunication control and status information to a telephone switching system via link interface 214. Converters 212 and 213 are utilized to convert information received from link interface 214 and transmitted to link interface 214. This conversion may require a digital-to-analog or analog-to-digital type conversion or may require the conversion of audio information encoded in one digital protocol to another digital protocol.

Echo canceller 202 performs the functions of reducing the echoes caused by acoustic paths 207 by adjusting speaker and acoustic path models. In addition, echo canceller 202 provides to controller 201 the changes in acoustic path 207.

D/A converter 211 and amplifier 209 receive encoded digital information from converter 213 or signal generator 229 and transform this information into audio information that speaker 208 produces as audio signals. This audio information can be within the human hearing

range or above or below the human hearing range. Microphone 206 is responsive to the echoes generated by acoustic paths 207 and any human speech or ambient audio information present to transmit this information to amplifier 204. In turn, A/D converter 203 converts it to digital information.

Controller 201 consists of processor 216 which provides control by executing programs stored in memory 217. Operating system 218 supplies the overall control. Processor 216 stores information in data 219. Change detection 221 is utilized to determine if a change indicating the absence or presence of a user has been received from echo canceller 202. Control routine 222 performs the overall control functions of the telecommunication terminal. The operations of echo canceller 202 with the exception of signal generator 229 and switch 227 are described in greater detail in U.S. Patent No. 5,680,450 which is hereby incorporated by reference. In addition to signal generator 229 and switch 227, the output of echo filter modifier 226 to acoustic path model 224 is also transmitted to controller 201. In the above incorporated U.S. patent, speaker model 223 and acoustic path model 224 are illustrated and discussed as each having two separate subunits. That has not been shown in FIG. 2 simply to reduce the detail within the figure. However, one skilled in the art would readily realize that speaker model 223 and acoustic path model 224 indeed can be made up of two or more sub units. Acoustic path model 224 models the acoustic path 207. Acoustic path model 224 is iteratively

developed using the input received from echo filter modifier 226. Echo filter modifier 226 performs this operation in response to the digital audio output signal from converter 213 or signal generator 229 and the output of subtractor 228 utilizing operations described in detail in the above incorporated U.S. patent. Subtractor 228 is responsive to the information received from A/D converter 203 which represents the audio information received by microphone 206 in digital form and the output of acoustic path model 224. Speaker model 223 models the output of speaker 208 in digital form and transmits this digital information to acoustic path model 224. Speaker model 223, acoustic path model 224, subtractor 228, echo filter modifier 226, switch 227 and signal generator 229 can be implemented using separate digital signal processors or may be implemented on one DSP. In addition, echo canceller 202 may also be implemented by processor 216.

Switch 227 and signal generator 229 are controlled by processor 216. Switch 227 either selects the output of signal generator 229 or converter 213 and transmits the selected information to D/A converter 211, speaker model 223, and echo filter modifier 226.

Signal generator 229 is used by processor 216 to generate a ringing signal in response to an incoming call and to also generate other audio tones commonly utilized by a telecommunication terminal. In addition, signal generator 229 is utilized to generate the audio tones to be used to evaluate the acoustic paths 207 when the user is absent or present from the telecommunication terminal.

These test tones may be within the human hearing range or above or below the human hearing range.

FIG. 3 illustrates, in block diagram form, a telecommunication terminal such as telecommunication terminal 108 or IP telephone 112 of FIG. 1. Controller 301 performs overall control of the telecommunication terminal. User interface 331 consists of a handset, buttons, indicators, displays, etc. that are normally found on a telecommunication terminal. Controller 301 receives and transmits telecommunication control and status and audio information to a telephone switching system via link interface 314.

Echo detector 302 performs the functions of reducing the echoes caused by acoustic paths 307 by adjusting speaker and acoustic path models. In addition, echo detector 302 provides to controller 301 the changes in acoustic path 307.

D/A converter 311 and amplifier 309 receive encoded digital information from signal generator 329 and transform this information into audio information that speaker 308 produces as audio signals. This audio information can be within the human hearing range or above or below the human hearing range. Microphone 306 is responsive to the echoes generated by acoustic paths 307 and any human speech or ambient audio information present to transmit this information to amplifier 304. In turn, A/D converter 303 converts it to digital information.

Controller 301 consists of processor 316 which provides control by executing programs stored in

memory 317. Operating system 318 supplies the overall control. Processor 316 stores information in data 319. Change detection 321 is utilized to determine if a change indicating the absence or presence of a user has been received from echo detector 302. Control routine 322 performs the overall control and audio processing functions of the telecommunication terminal. In general, the operations of echo detector 302 are described in U.S. Patent No. 5,680,450 which is hereby incorporated by reference. Acoustic path model 324 models the acoustic path 307. Acoustic path model 324 is iteratively developed using the input received from echo filter modifier 326. Echo filter modifier 326 performs this operation in response to the digital audio output signal of signal generator 329 and the output of subtractor 328 utilizing operations described in detail in the above incorporated U.S. patent. Subtractor 328 is responsive to the information received from A/D converter 303 which represents the audio information received by microphone 306 in digital form and the output of acoustic path model 324. Speaker model 323 models the output of speaker 308 in digital form and transmits this digital information to acoustic path model 324. Speaker model 323, acoustic path model 324, subtractor 328, echo filter modifier 326, and signal generator 329 can be implemented using separate digital signal processors or may be implemented on one DSP. In addition, echo detector 302 may also be implemented by processor 316.

Signal generator 329 are controlled by processor 316. Signal generator 329 transmits its output to

D/A converter 311, speaker model 323, and echo filter modifier 326. Signal generator 329 is used by processor 316 to generate a ringing signal in response to an incoming call and to also generate other audio tones commonly utilized by a telecommunication terminal. In addition, signal generator 329 is utilized to generate the audio tones to be used to evaluate the acoustic paths 307 when the user is absent or present from the telecommunication terminal. These test tones may be within the human hearing range or above or below the human hearing range.

FIGS. 4 and 5 illustrate, in flowchart form, operations performed by one embodiment of a telecommunication terminal. After being started from block 401, decision block 402 determines whether the user wants to train the detection method which determines the presence or non-presence of the user at the telecommunication terminal. If the answer in decision block 402 is yes, control is transferred to block 501 of FIG. 5. If the answer in decision block 402 is no, control is transferred to decision block 403 which determines if there has been a change in the user's presence as detected by the detection method. If the answer is no in decision block 403, control is transferred back to decision block 402. If the answer is yes in decision block 403, control is transferred to decision block 404 which determines if the change in presence is to be transmitted to the system, which in this case means telecommunication switching system to which the telecommunication terminal is connected, or if the change will be processed solely by the telecommunication

terminal. The change in presence will determine certain operations that will be taken for incoming and other telecommunication operations. The question being determine in decision block 404 is whether the switching system will handle these types of operations or the telecommunication terminal itself will. An example of this is if the send-all-call feature is to be activated when the user is not present. The switching system such as telecommunication switching system 100 in FIG. 1 can perform the necessary operations. On the other hand, it is possible for the telecommunication terminal to perform all operations required by the send all call feature. If the answer in decision block 404 is no, block 407 processes the change for future operations within the telecommunication terminal before transferring control back to decision block 402. In the case where the non presence of the user will activate the send all call feature, the message sent to the switching system by block 406 will cause this feature to be activated on the telecommunication system.

Block 501 of FIG. 5 first measures the condition with the user in different locations in the enclosure in which the telecommunication terminal is located. The enclosure may be an office, a cubicle, or other enclosures well known and utilized within the working environment. After the conditions such as the change to the acoustic path model 224 of FIG. 2 have been determined in block 501, the user then leaves the enclosure, and the changes made to the acoustic path model 224 of FIG. 2 are once again recorded. Finally, block 503 determines a threshold point

between the presence and non-presence conditions before returning control back to FIG. 4.

FIG. 6 illustrates, in block diagram form, a telecommunication terminal that utilizes a heat detector to determine the presence of the user based on the body heat given off by the user. Elements 601 through 611 perform similarly to elements 301, 314-322 and 331 of FIG. 3. With the exception, that processor 603 also performs functions for determining the output of heat detector 612. The operation of heat detector 612 and those performed by processor 603 with respect to heat detector 612 are disclosed in greater detail in U.S. Patent No. 5,627,375 which is hereby incorporated by reference. Heat detector 612 corresponds to pyroelectric sensing circuit 220 and the operations of processor 603 correspond to operations of microprocessor 110 of incorporated U.S. Patent No. 5,627,375. U.S. Patent No. 5,315,434, which is also hereby incorporated by reference, also shows the operation of detecting the presence of a human by the heat given off by the human body.